WHAT IS CLAIMED IS:

1. A piezoelectric transformer comprising:

a piezoelectric substrate mainly formed of a piezoelectric material,

primary electrodes which are formed on said piezoelectric substrate and to which a voltage is applied,

a secondary electrode which is formed on said piezoelectric substrate and from which a voltage higher than the voltage applied to said primary electrode is output, and

a third electrode which is formed on said piezoelectric substrate and from which a voltage lower than the voltage output from said secondary electrode is output.

2. A piezoelectric transformer comprising:

a drive portion having a set of primary electrodes formed on the opposite faces of a rectangular plate in the direction of the thickness thereof, said rectangular plate having its longitudinal direction as its main direction and mainly formed of a piezoelectric material,

a power generation portion having a set of secondary electrodes formed on said rectangular plate in the longitudinal direction thereof, and

a third electrode formed between said secondary electrodes.

3. A piezoelectric transformer in accordance with claim

2, wherein:

said third electrode is formed in the range of L/8 or less from the center position of said rectangular plate in the longitudinal direction thereof when the length of said rectangular plate is L, and

the vibration mode to be used is the $\lambda/2$ vibration mode.

4. A piezoelectric transformer in accordance with claim 2, wherein:

said third electrode is formed in the range of L/8 or less from the center of said power generation portion when the length of the rectangular plate is L, and

the vibration mode to be used is the λ vibration mode.

5. A piezoelectric transformer comprising:

a drive portion having a set of primary electrodes formed on the opposite faces of a rectangular plate in the direction of the thickness thereof, said rectangular plate having its longitudinal direction as its main direction and mainly formed of a piezoelectric material,

a third electrode portion having a set of third electrodes formed on the opposite faces of said rectangular plate in the direction of the thickness thereof, and

a power generation portion having a set of secondary electrodes formed on said rectangular plate.

6. A piezoelectric transformer in accordance with claim 5, wherein:

said primary electrodes are formed away from an end face of said rectangular plate in the longitudinal direction thereof by a predetermined distance, and

said third electrodes are formed within a predetermined distance from said end face.

7. A piezoelectric transformer in accordance with claim 5, wherein:

said primary electrodes are formed in a substantially half region of said rectangular plate in the longitudinal direction thereof, except for a predetermined region, and

said third electrodes are formed in said predetermined region.

8. A piezoelectric transformer in accordance with claim 7, wherein:

said third electrodes are provided at a substantially half position of said primary electrodes in the longitudinal direction of said rectangular plate, and

drive is carried out in the one wavelength vibration mode of the vibration in the longitudinal direction.

9. A piezoelectric transformer in accordance with claim 7, wherein:

said third electrodes are provided near the center of said rectangular plate in the longitudinal direction thereof, and

drive is carried out in the half-wavelength vibration mode of the vibration in the longitudinal direction.

10. A piezoelectric transformer comprising:

a rectangular plate having its longitudinal direction as its main direction and mainly formed of a piezoelectric material,

a drive portion having a set of primary electrodes formed on the opposite faces of said rectangular plate in the direction of the thickness thereof and at a region retracted from an end face of said rectangular plate in the longitudinal direction thereof,

a power generation portion having a set of secondary electrodes formed on said rectangular plate, and

a set of third electrodes formed on the opposite faces of said rectangular plate in the direction of the thickness thereof and in a region from which said primary electrodes are retracted.

11. A piezoelectric transformer comprising:

a rectangular plate having its longitudinal direction as its main direction thereof and mainly formed of a piezoelectric material,

a drive portion having a set of primary electrodes formed on the opposite faces of said rectangular plate in the direction of the thickness thereof and at a region retracted from an end face of said rectangular plate in the longitudinal direction thereof,

a power generation portion having a set of secondary electrodes formed on said rectangular plate, and

a set of third electrodes formed on the opposite faces

of said rectangular plate in the direction of the width thereof and adjacent to a region from which said primary electrodes are retracted.

12. A piezoelectric transformer in accordance with one of claims 2 to 11, wherein one of said set of secondary electrodes is shared with one of said set of primary electrodes, and one of said set of third electrodes is shared with one of said set of primary electrodes.

13. A piezoelectric transformer in accordance with one of claims 2 to 11, wherein said primary electrodes are formed by stacking piezoelectric sheets and internal electrodes alternatively.

14. A piezoelectric transformer drive circuit comprising:

a piezoelectric transformer for outputting a voltage input to a primary terminal from a secondary terminal by virtue of a piezoelectric effect, said piezoelectric transformer having a sensor electrode for detecting a voltage lower than the output voltage from said secondary terminal,

a drive circuit for driving said piezoelectric transformer,

a variable oscillation circuit for supplying a desired frequency and a desired voltage from said drive circuit to said piezoelectric transformer,

a discharge tube, the input terminal of which receives the output voltage of said piezoelectric transformer and the output

terminal of which is connected to a feedback resistor,

an overvoltage protection circuit for detecting the output voltage from said sensor electrode, for comparing said output voltage with a first reference voltage and for outputting the result of the comparison,

comparison means for comparing the voltage value of said feedback resistor with a second reference voltage so that the current flowing through said discharge tube becomes constant and for outputting the result of the comparison,

a frequency control circuit for controlling the drive frequency of said piezoelectric transformer on the basis of the result of the comparison from said overvoltage protection circuit before the lighting start of said discharge tube and for controlling the drive frequency of said piezoelectric transformer on the basis of the result of the comparison from said comparison means while said discharge tube is lit.

15. A piezoelectric transformer drive method for outputting a voltage input to a primary terminal from a secondary terminal by virtue of a piezoelectric effect, wherein:

a voltage is detected from a third electrode which is provided on said piezoelectric transformer to output a voltage lower than the output voltage of said secondary terminal, and

the result of said detection is used for overvoltage protection for the output voltage of said secondary terminal of said piezoelectric transformer.

16. A cold cathode tube drive apparatus using a piezoelectric transformer comprising:

a piezoelectric transformer for stepping up the voltage input from a primary electrode by a piezoelectric effect, for outputting the stepped-up voltage from a secondary electrode and for outputting a detection voltage in proportion to the output voltage from a sensor electrode,

a piezoelectric transformer drive portion for generating an AC voltage, the frequency of which is variable, for amplifying said AC voltage to a predetermined level and for supplying the amplified voltage to said piezoelectric transformer,

a cold cathode tube driven by the output voltage from said secondary electrode of said piezoelectric transformer,

a resistor for detecting the current flowing through said cold cathode tube as a voltage,

an oscillation control circuit for controlling the frequency of said AC voltage output from said piezoelectric transformer drive portion on the basis of said voltage detected by said resistor so that the current flowing through said cold cathode tube becomes a predetermined value,

an overvoltage protection circuit for controlling the frequency of said AC voltage output from said piezoelectric transformer drive portion on the basis of said detection voltage from said sensor electrode via said oscillation control circuit before the lighting start of said cold cathode tube and for stopping

the frequency control of said AC voltage output from said piezoelectric transformer drive portion in the case when said detection voltage from said sensor electrode exceeds a predetermined value.

17. A cold cathode tube drive apparatus using a piezoelectric transformer in accordance with claim 16, wherein said piezoelectric transformer has said primary electrodes and said sensor electrodes disposed opposite to each other so as to form a polarized structure in the direction of the thickness of a piezoelectric element, has said secondary electrode disposed so as to form a polarized structure in the longitudinal direction of said piezoelectric element, and steps up the input voltage applied to said primary electrode to obtain an output voltage from said secondary electrode and to obtain a detection voltage in proportion to said output voltage from said sensor electrode.

18. A cold cathode tube drive apparatus using a piezoelectric transformer in accordance with claim 16, wherein said piezoelectric transformer is characterized in that in a first region in the longitudinal direction of a piezoelectric element, a first electrode is disposed on one of the surfaces in the direction of the thickness, a second electrode and a third electrode are disposed in sequence from said first electrode in said direction of the thickness inside said piezoelectric element, a fourth electrode is disposed on the other surface of said piezoelectric element opposite to said surface so that said electrodes are

disposed opposite to each other at predetermined distances and close to one of the end faces of said piezoelectric element in the longitudinal direction thereof, and a fifth electrode is disposed on the other end face opposite to said end face, and also characterized in that in a second region in the longitudinal direction of said piezoelectric element, a polarization structure is formed in the longitudinal direction of said piezoelectric element, said first and second electrodes are used as said primarily electrodes, said third and fourth electrodes are used as said sensor electrodes, said fifth electrode is used as said secondary electrode, and the input voltage applied to said primary electrode is step up to obtain an output voltage from said secondary electrode and to obtain a detection voltage in proportion to said output voltage from said sensor electrode.

19. A cold cathode tube drive apparatus using a piezoelectric transformer in accordance with claim 16, wherein said piezoelectric transformer drive portion comprises:

an electromagnetic transformer having a primary winding to which said DC power source is supplied and a secondary winding connected to said primary electrode of said piezoelectric transformer, for stepping up said AC voltage and for supplying the stepped-up voltage to said piezoelectric transformer, and

a switching circuit for controlling the frequency of said AC voltage supplied to said piezoelectric transformer by switching said DC voltage supplied to said primary winding of said

electromagnetic transformer.

20. A cold cathode tube drive apparatus using a piezoelectric transformer in accordance with claim 17, wherein said piezoelectric transformer drive portion comprises:

an electromagnetic transformer having a primary winding to which said DC power source is supplied and a secondary winding connected to said primary electrode of said piezoelectric transformer, for stepping up said AC voltage and for supplying the stepped-up voltage to said piezoelectric transformer, and

a switching circuit for controlling the frequency of said AC voltage supplied to said piezoelectric transformer by switching said DC voltage supplied to said primary winding of said electromagnetic transformer.

21. A cold cathode tube drive apparatus using a piezoelectric transformer in accordance with claim 18, wherein said piezoelectric transformer drive portion comprises:

an electromagnetic transformer having a primary winding to which said DC power source is supplied and a secondary winding connected to said primary electrode of said piezoelectric transformer, for stepping up said AC voltage and for supplying the stepped-up voltage to said piezoelectric transformer, and

a switching circuit for controlling the frequency of said AC voltage supplied to said piezoelectric transformer by switching said DC voltage supplied to said primary winding of said electromagnetic transformer.

22. A cold cathode tube drive apparatus using a piezoelectric transformer in accordance with claim 19, wherein said electromagnetic transformer is formed of first and second electromagnetic transformers, said switching circuit is provided with first and second switching transistors connected to the primary windings of said first and second electromagnetic transformers respectively, and said first and second electromagnetic transformers are used in series or parallel to drive said piezoelectric transformer.

23. A cold cathode tube drive apparatus using a piezoelectric transformer in accordance with claim 20, wherein said electromagnetic transformer is formed of first and second electromagnetic transformers, said switching circuit is provided with first and second switching transistors connected to the primary windings of said first and second electromagnetic transformers respectively, and said first and second electromagnetic transformers are used in series or parallel to drive said piezoelectric transformer.

24. A cold cathode tube drive apparatus using a piezoelectric transformer in accordance with claim 21, wherein said electromagnetic transformer is formed of first and second electromagnetic transformers, said switching circuit is provided with first and second switching transistors connected to the primary windings of said first and second electromagnetic transformers respectively, and said first and second

electromagnetic transformers are used in series or parallel to drive said piezoelectric transformer.

25. A cold cathode tube drive apparatus using a piezoelectric transformer in accordance with claim 22, wherein the AC voltage supplied from one of said first and second electromagnetic transformers to said piezoelectric transformer is used as a reference voltage, and said piezoelectric transformer is driven on the basis of the difference value between said detection voltage from said sensor electrode and said reference voltage.

26. A cold cathode tube drive apparatus using a piezoelectric transformer in accordance with claim 23, wherein the AC voltage supplied from one of said first and second electromagnetic transformers to said piezoelectric transformer is used as a reference voltage, and said piezoelectric transformer is driven on the basis of the difference value between said detection voltage from said sensor electrode and said reference voltage.

27. A cold cathode tube drive apparatus using a piezoelectric transformer in accordance with claim 24, wherein the AC voltage supplied from one of said first and second electromagnetic transformers to said piezoelectric transformer is used as a reference voltage, and said piezoelectric transformer is driven on the basis of the difference value between said detection voltage from said sensor electrode and said reference

voltage.

28. A cold cathode tube drive apparatus using a piezoelectric transformer in accordance with any one of claims 17, 20 and 23, wherein said piezoelectric transformer is driven in the primary mode of vertical vibration in the longitudinal direction by an AC voltage signal, the half-wave length of which is equal to the length of said piezoelectric transformer in the longitudinal direction thereof.

29. A cold cathode tube drive apparatus using a piezoelectric transformer in accordance with any one of claims 18, 21 and 24, wherein said piezoelectric transformer is driven in the primary mode of vertical vibration in the longitudinal direction by an AC voltage signal, the half-wave length of which is equal to the length of said piezoelectric transformer in the longitudinal direction thereof.

30. A cold cathode tube drive apparatus using a piezoelectric transformer in accordance with any one of claims 17 to 20, wherein said piezoelectric transformer is driven in the secondary mode of vertical vibration in the longitudinal direction by an AC voltage signal, the one wavelength of which is equal to the length of said piezoelectric transformer in the longitudinal direction thereof.

31. A cold cathode tube drive apparatus using a piezoelectric transformer in accordance with any one of claims 16 to 18, wherein said oscillation control circuit is provided

with a switching device for selectively controlling the frequency of said AC voltage output from said variable oscillation circuit on the basis of said detection voltage from said sensor electrode before the lighting start of said cold cathode tube or on the basis of the detection voltage by said resistor after the lighting start of said cold cathode tube.

32. A cold cathode tube drive apparatus using a piezoelectric transformer in accordance with any one of claims 16 to 20, 22 and 23, wherein a voltage divider circuit comprising resistors is connected to said sensor electrode of said piezoelectric transformer, and the output of said voltage divider circuit is used as said detection voltage from said sensor electrode.

33. A cold cathode tube drive apparatus using a piezoelectric transformer in accordance with claim 28, wherein a voltage divider circuit comprising resistors is connected to said sensor electrode of said piezoelectric transformer, and the output of said voltage divider circuit is used as said detection voltage from said sensor electrode.

34. A cold cathode tube drive apparatus using a piezoelectric transformer in accordance with claim 29, wherein a voltage divider circuit comprising resistors is connected to said sensor electrode of said piezoelectric transformer, and the output of said voltage divider circuit is used as said detection voltage from said sensor electrode.

35. A cold cathode tube drive apparatus using a piezoelectric transformer in accordance with claim 30, wherein a voltage divider circuit comprising resistors is connected to said sensor electrode of said piezoelectric transformer, and the output of said voltage divider circuit is used as said detection voltage from said sensor electrode.

36. A cold cathode tube drive apparatus using a piezoelectric transformer in accordance with claim 31, wherein a voltage divider circuit comprising resistors is connected to said sensor electrode of said piezoelectric transformer, and the output of said voltage divider circuit is used as said detection voltage from said sensor electrode.

37. A cold cathode tube drive apparatus using a piezoelectric transformer in accordance with any one of claims 16 to 18, wherein the load connected to said sensor electrode is determined so that the relationship between the output capacitance of said piezoelectric transformer and said load connected to said secondary electrode is equal to the relationship between the capacitance between said sensor electrodes disposed opposite to each other and said load connected to said sensor electrode.

38. A cold cathode tube drive apparatus using a piezoelectric transformer in accordance with claim 37, wherein said load connected to said sensor electrode has at least double the resistance value of the impedance calculated by $1/(2 \times \pi \times fd \times Cs)$, wherein the capacitance between the pair of said sensor

electrodes is Cs and the resonance frequency of said piezoelectric transformer is fd.